Sustainably Designed Building Performance

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We've Begun.
Here is what we've found so far...

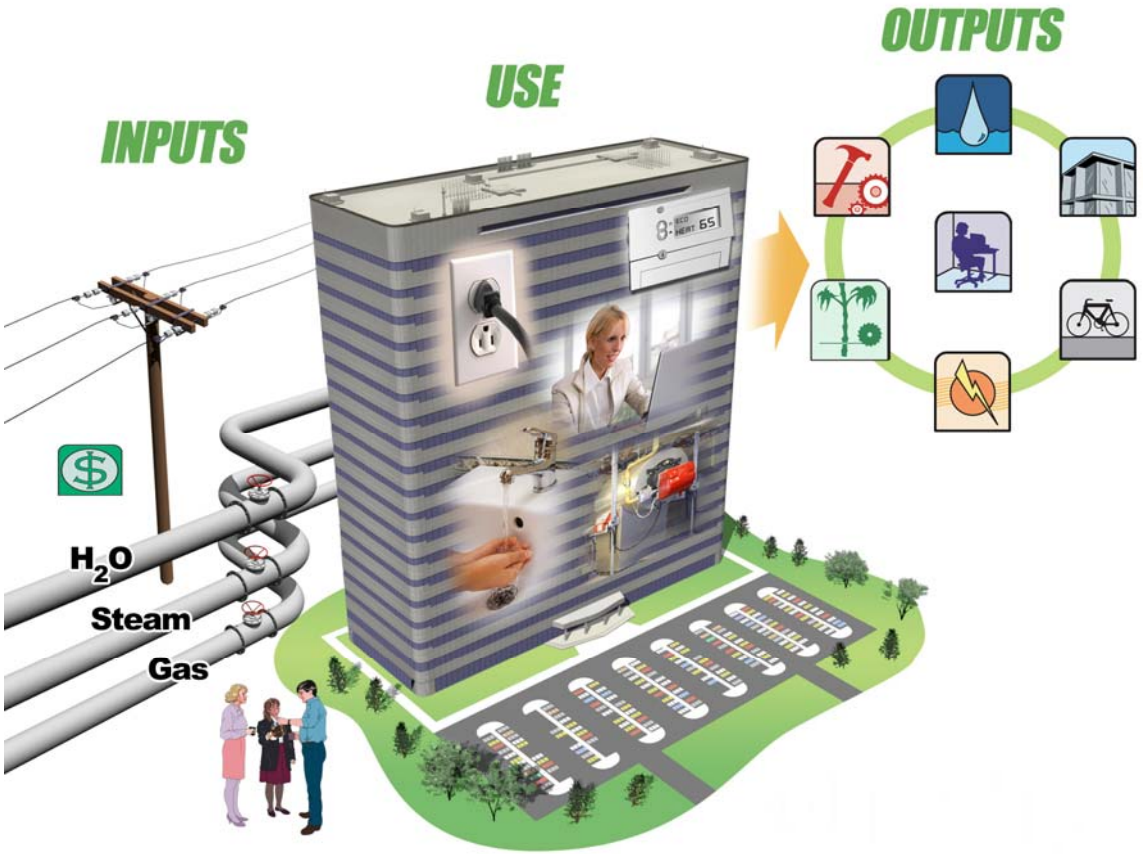
- Three major points based on the evidence
  - Sustainably designed buildings perform better than industry baselines
  - Design emphasis on a performance target equates to better performance
  - Consistent data collection allows for more accurate performance measurement analysis

There is much more to do!

Overview

- What is Whole Building Performance Measurement (WBPM)
- Results from current government studies
- Strategies for WBPM
- Lessons learned

What is Whole Building Performance Measurement?



- Building Characteristics
- Water
- Energy
- Maintenance & Operations
- Purchasing
- Health & Productivity
- Transportation

Whole-Building Performance Measurement involves measuring, not estimating or modeling, actual building related performance.

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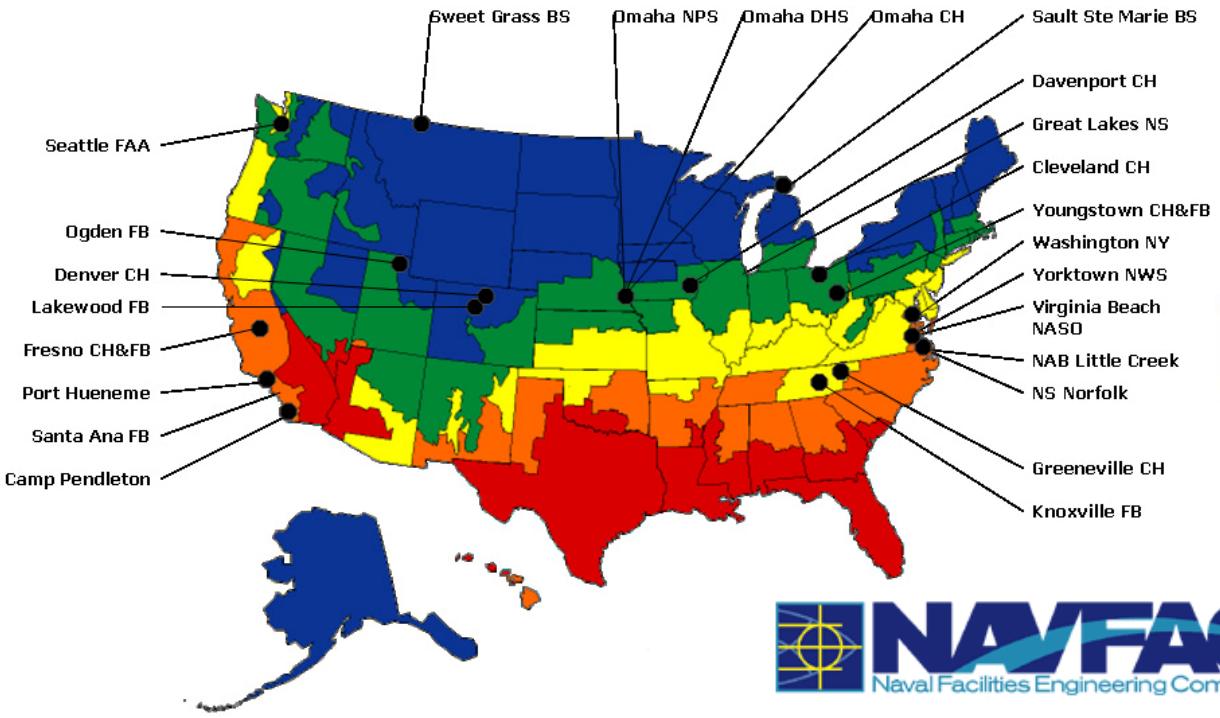
What the government is doing?

- Side-by-side comparisons of green and typically designed buildings
- Green portfolio compared to industry & internal standards
- Designing and constructing green buildings with WBPM integrated into design, compared to typical buildings



GSA

U.S.ARMY

FEMP

NAVFAC Naval Facilities Engineering Command

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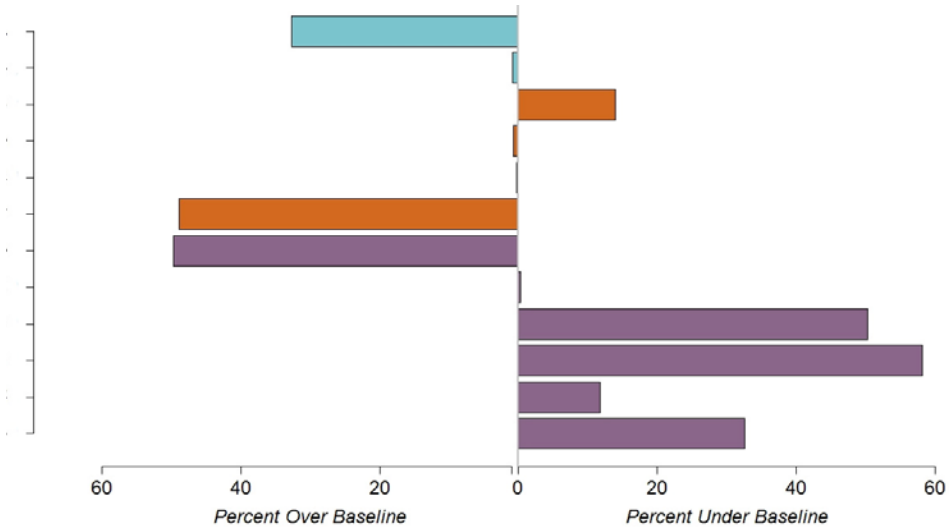
	Metric
Water 	Total Building Potable Water Use Indoor Potable Water Outdoor Water Use Process Water Use
Energy 	Total Building Energy Use Source Energy
Maintenance & Operations 	General Building Maintenance Grounds Maintenance Janitorial Service
Waste Generation & Recycling 	Solid Sanitary Waste Recycled Materials
Occupant Satisfaction 	Building Occupant Satisfaction and Self-Rated Productivity
Transportation 	Regular Commute

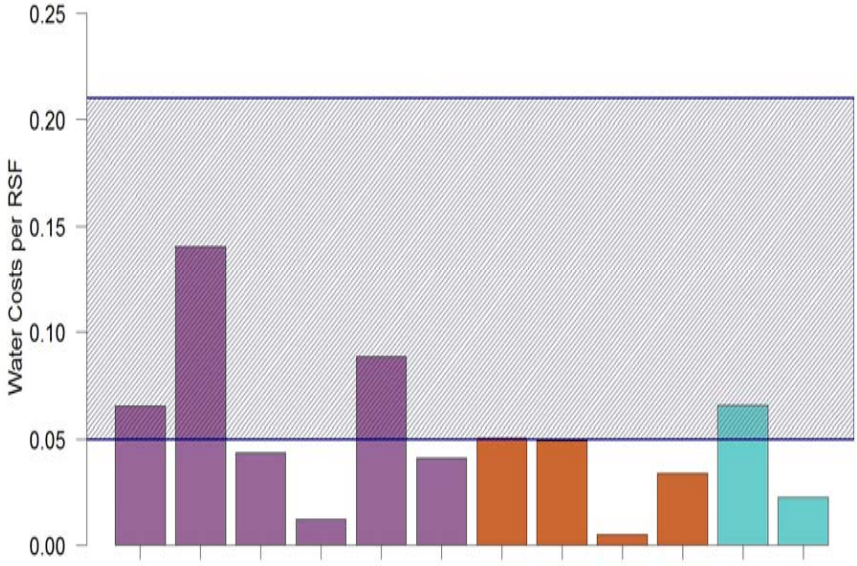
Sample Results and Findings from:

- 12 GSA Sustainably Designed Buildings compared to Industry Baseline data
- 5 Navy Sustainably Designed Buildings compared to 5 Navy Traditionally Designed Buildings

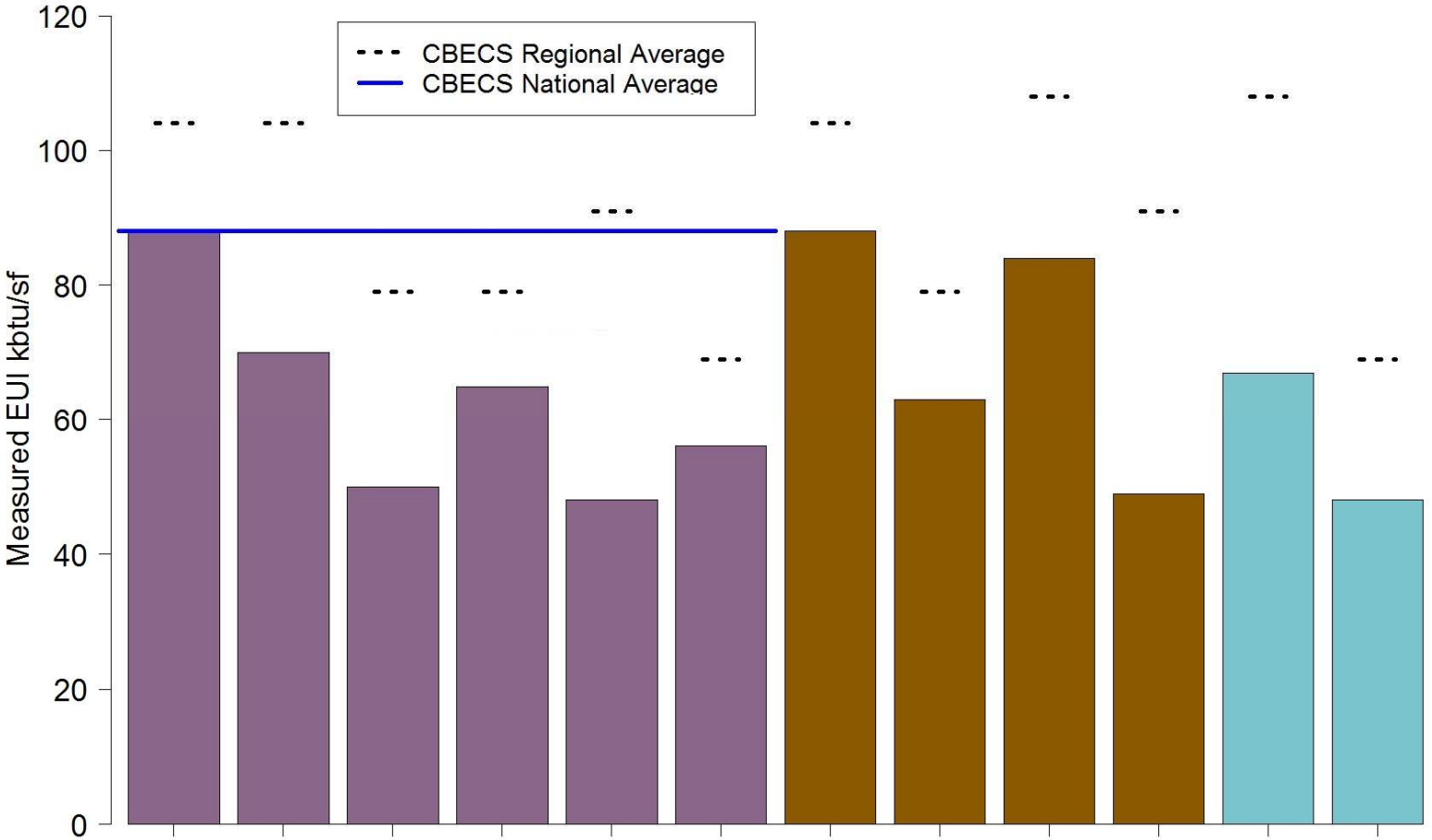
- Sustainably designed buildings perform better than industry baselines

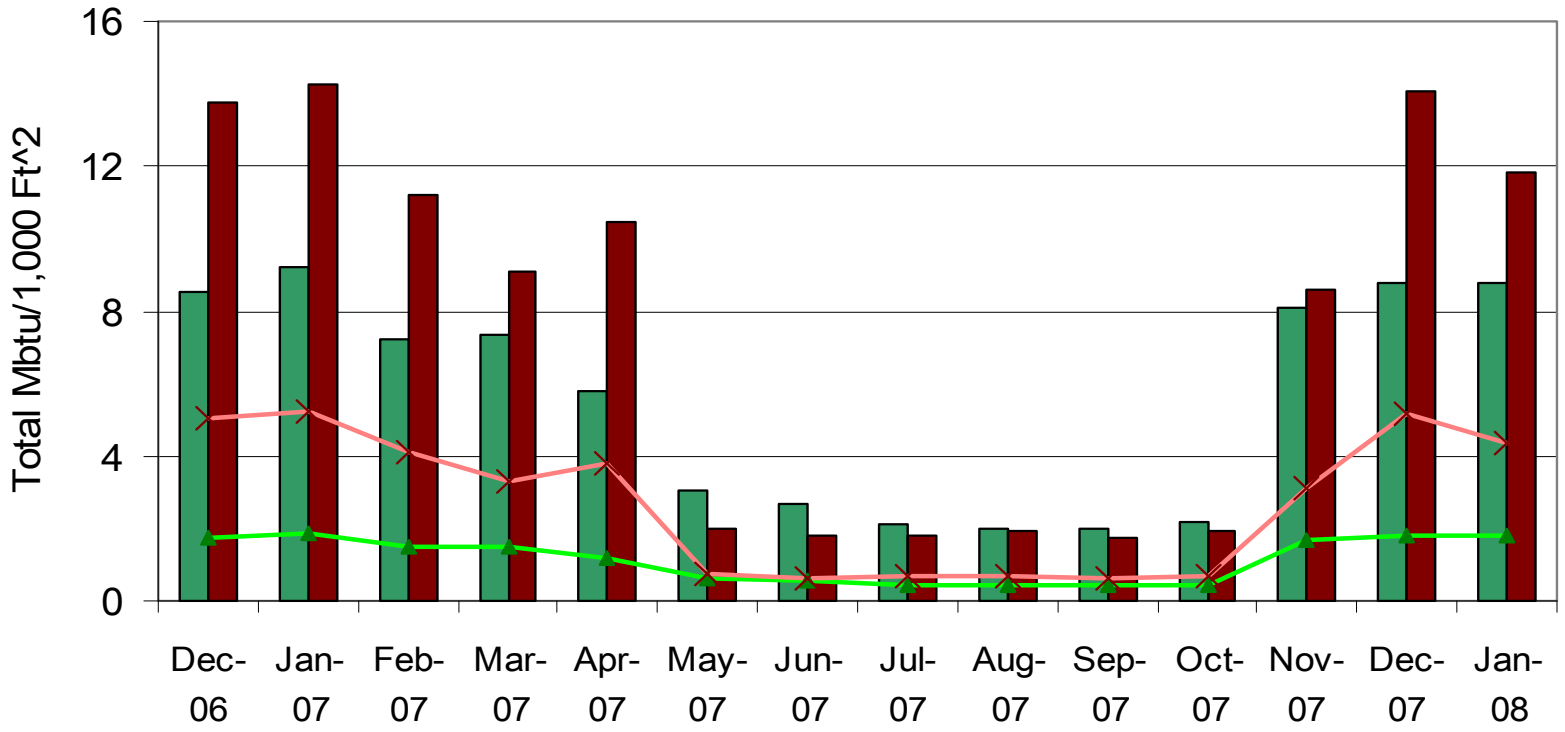
3% less domestic water use
60% lower water cost



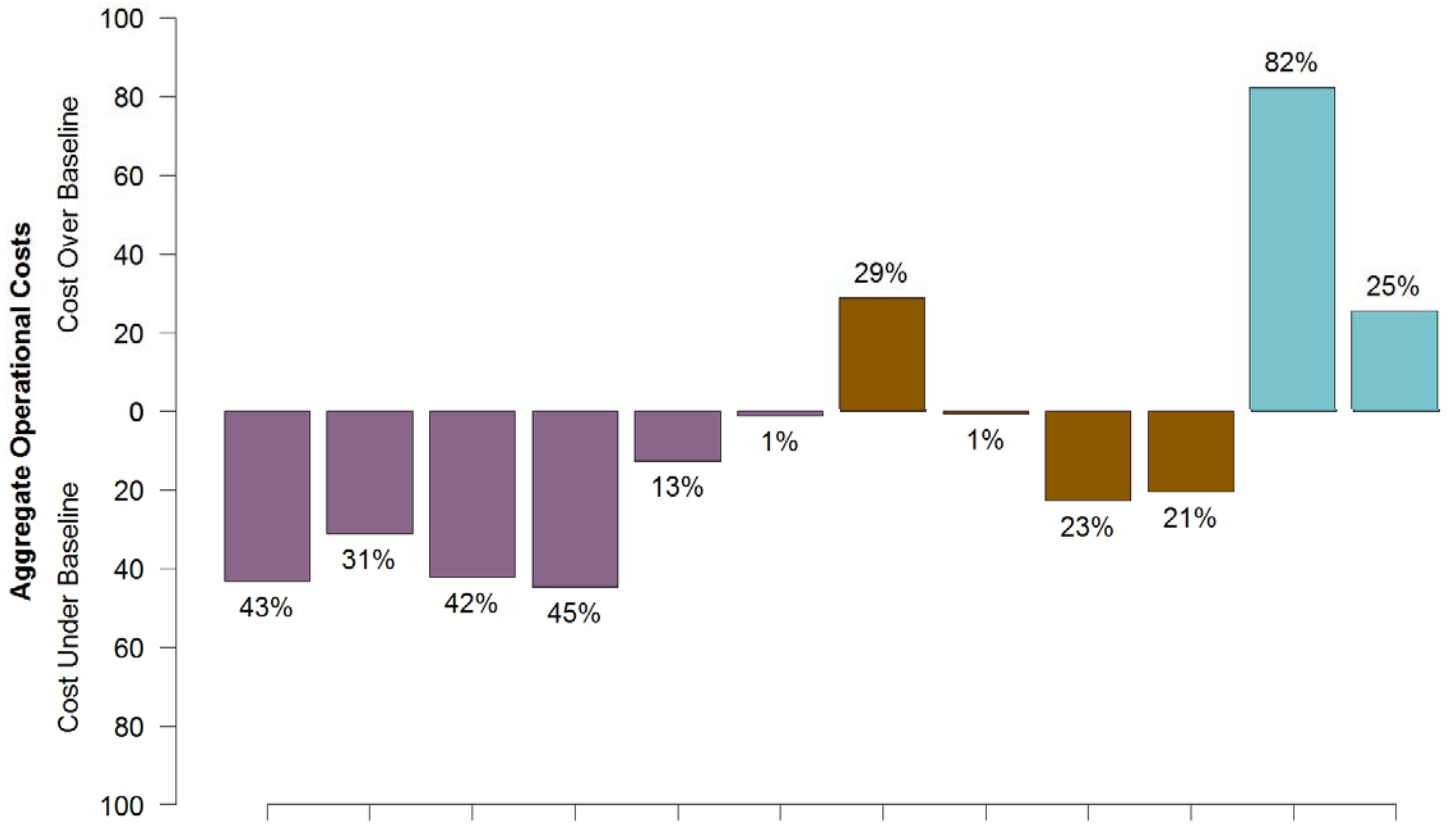


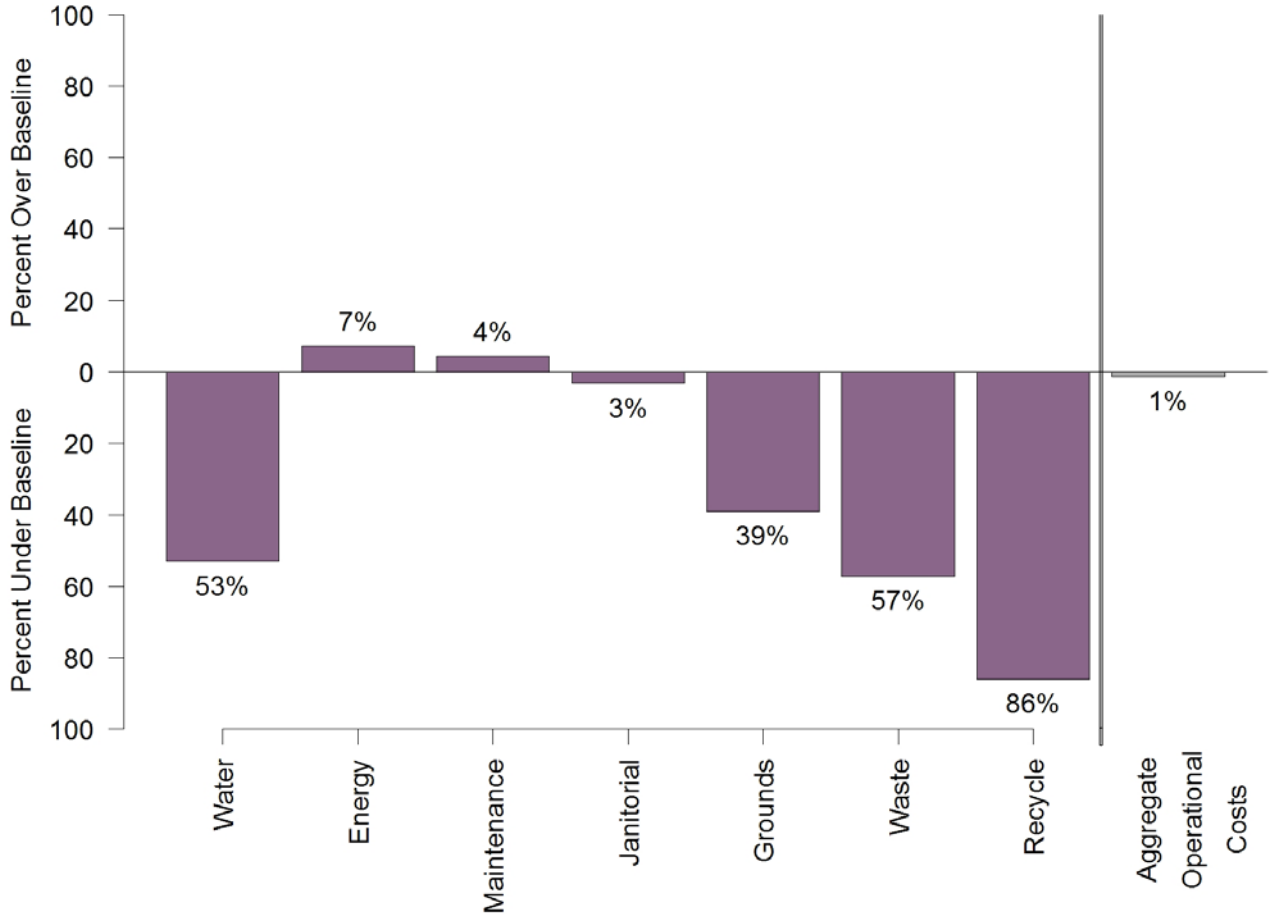
26% less energy use



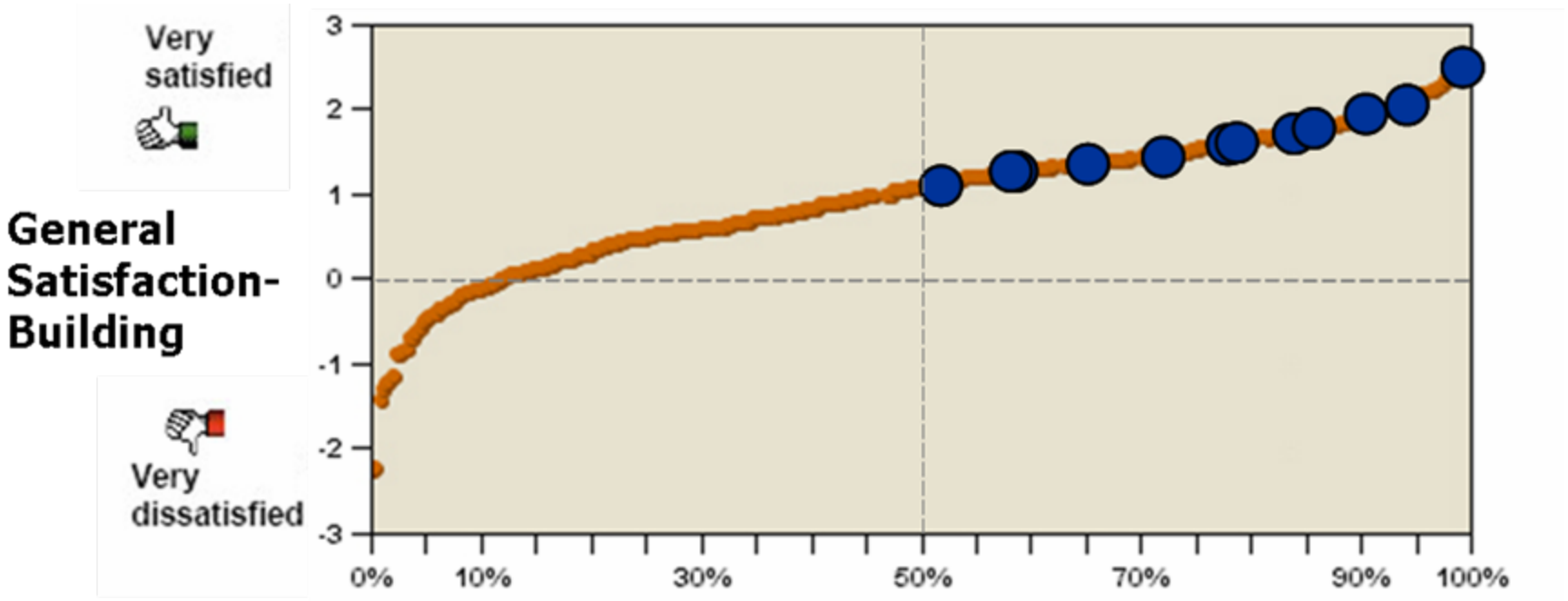


Cost 16% less to operate





Building occupants 27% more satisfied



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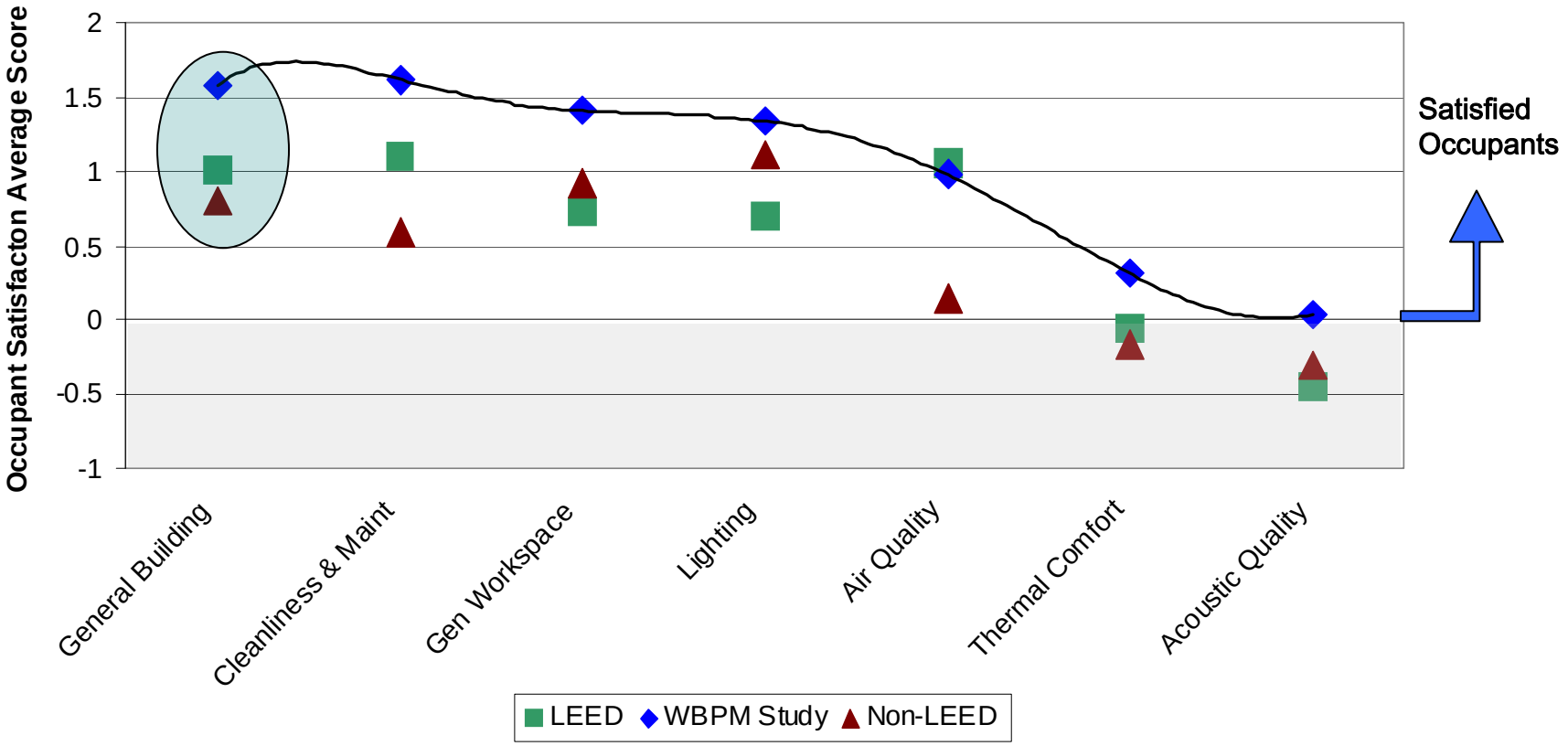
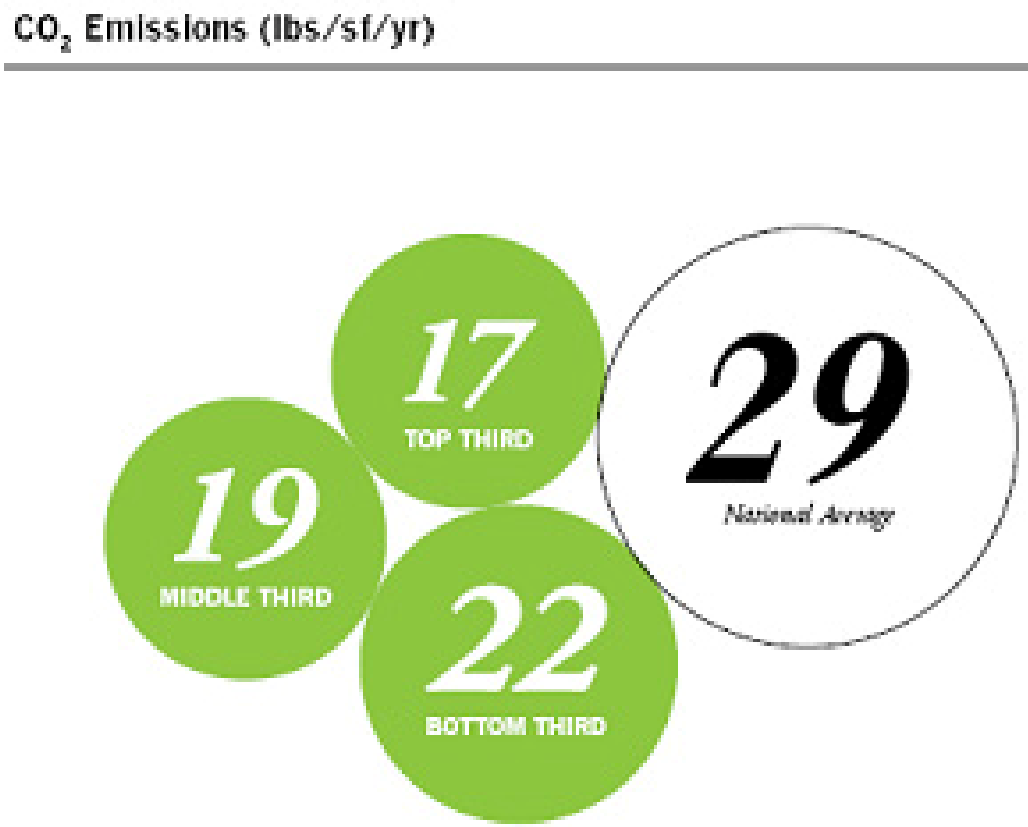
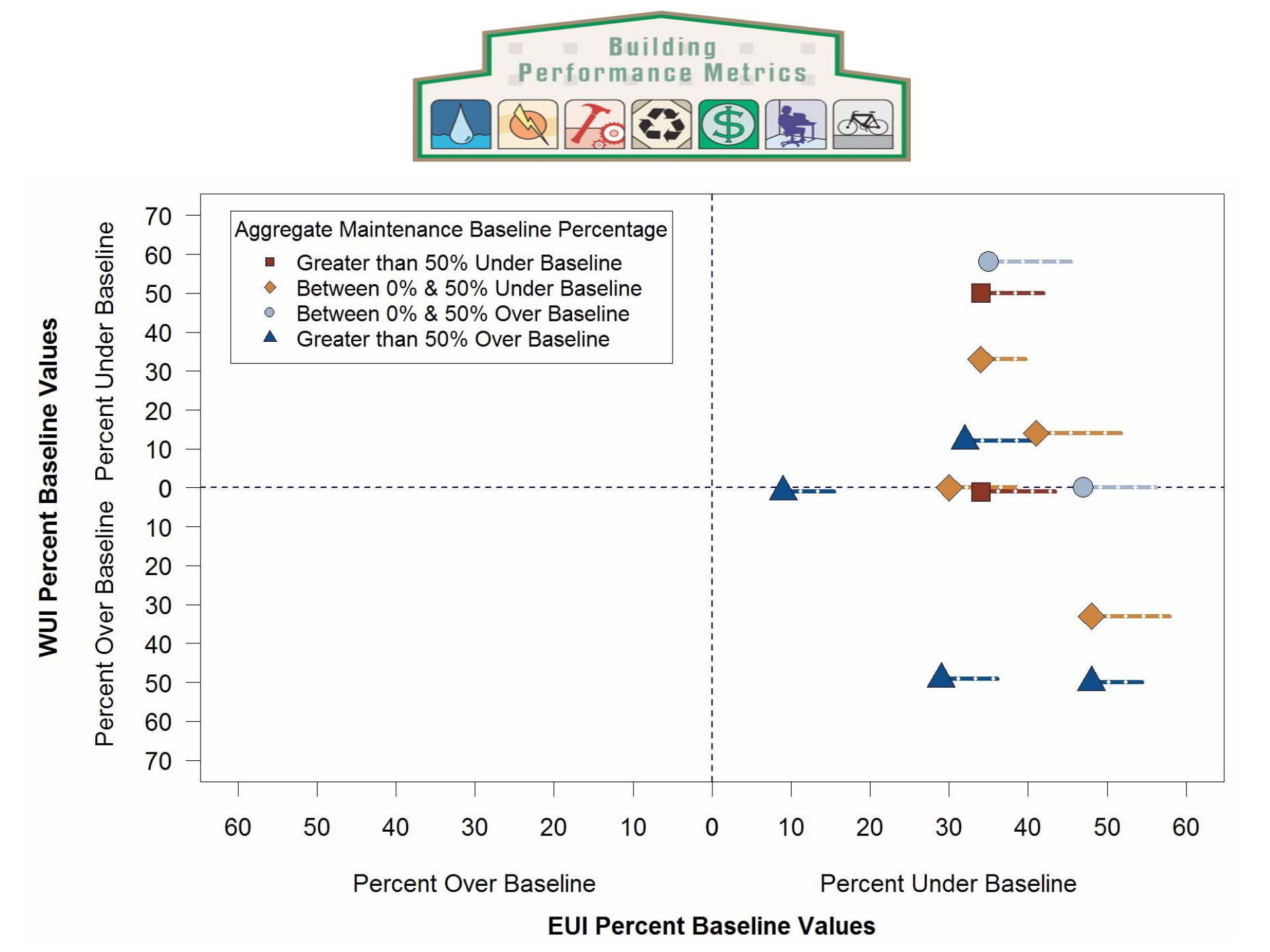


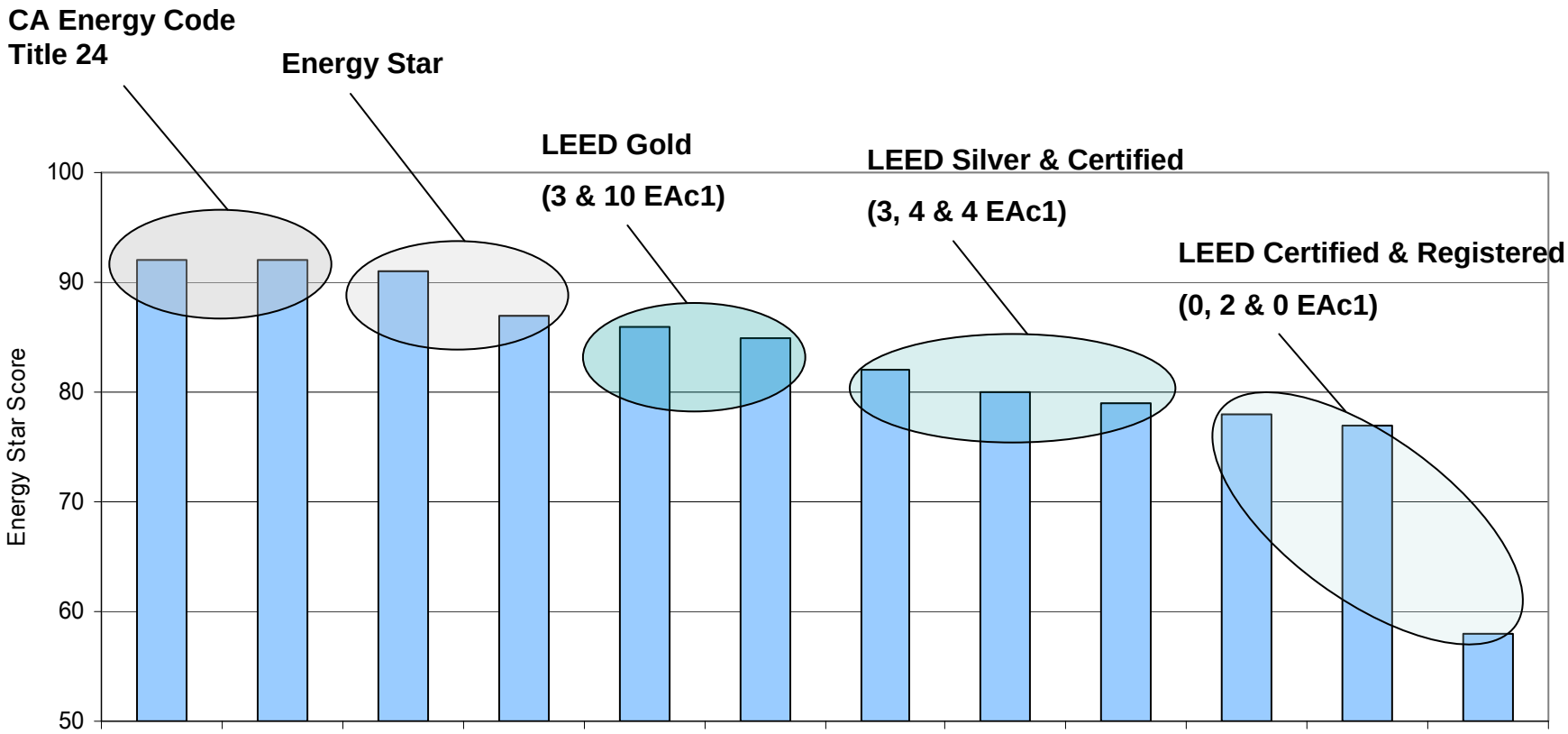
33% Fewer carbon dioxide equivalent emissions
All buildings better than industry average



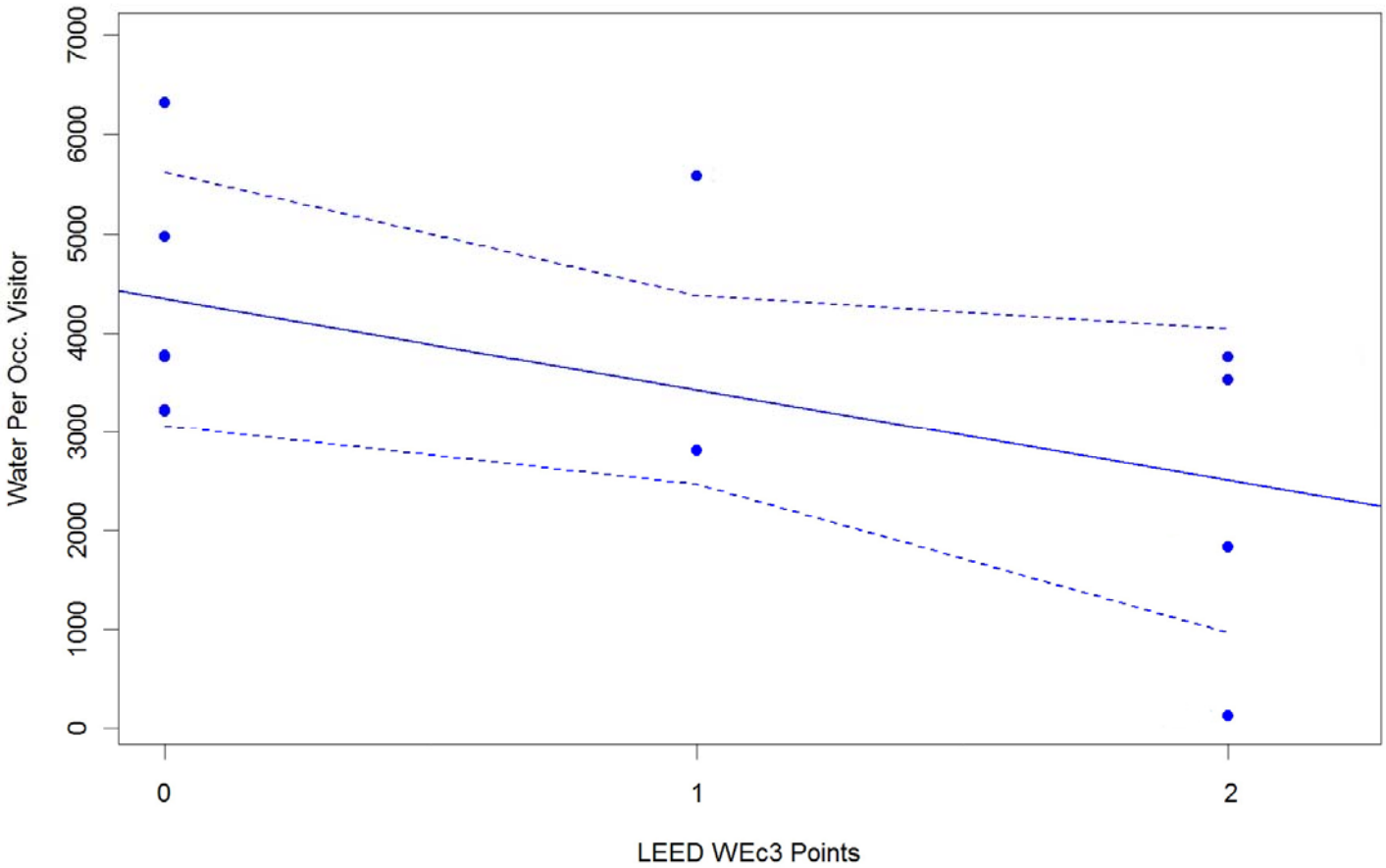

Building
Performance Metrics
Aggregate Maintenance Baseline Percentage
Greater than 50% Under Baseline
Between 0% & 50% Under Baseline
Between 0% & 50% Over Baseline
Greater than 50% Over Baseline
WUI Percent Baseline Values
Percent Over Baseline
Percent Under Baseline
70
60
50
40
30
20
10
0
10
20
30
40
50
60
Percent Over Baseline
Percent Under Baseline
EUI Percent Baseline Values

- Design emphasis on a performance target equates to better performance

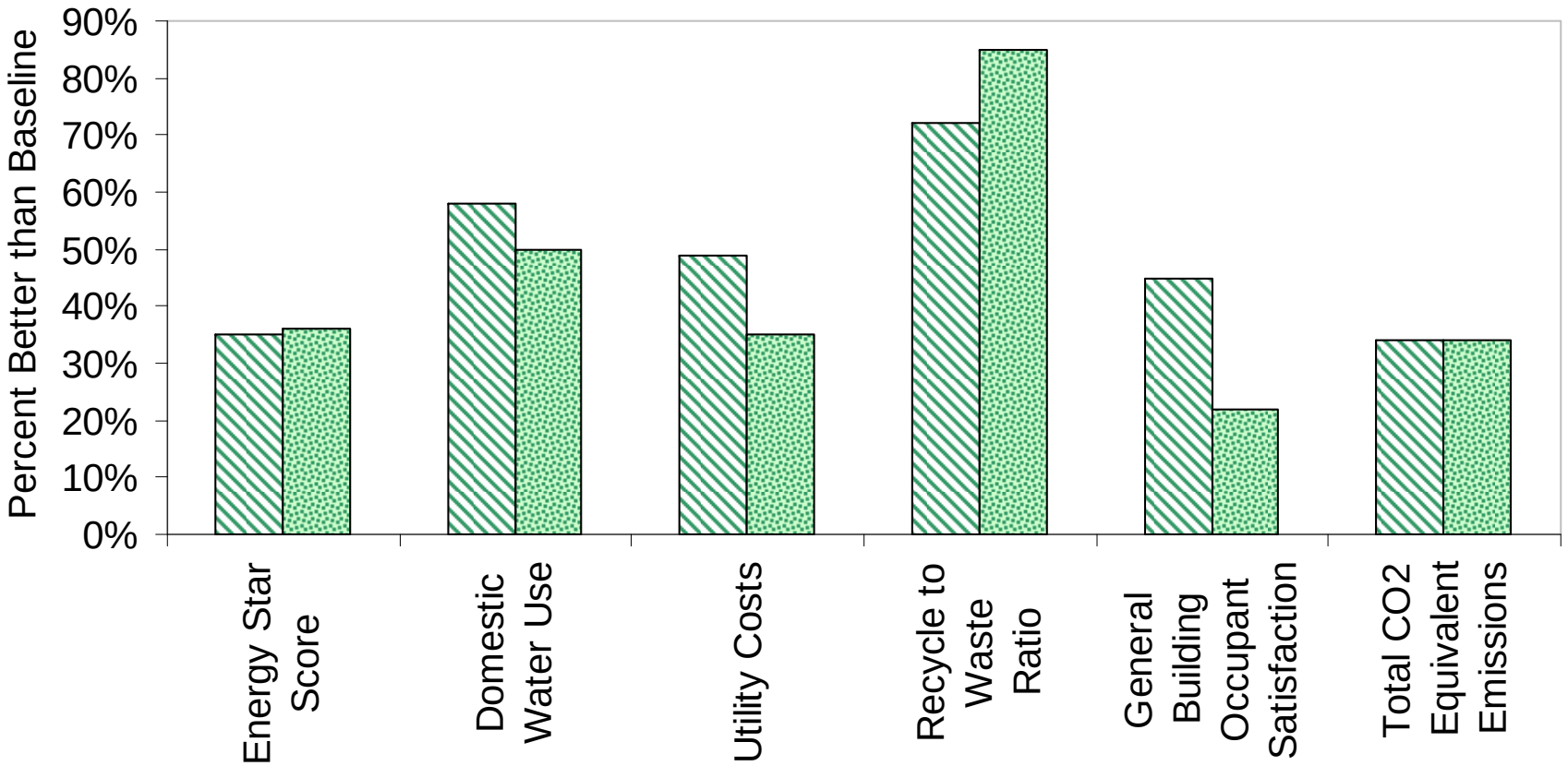
Energy Star scores and design intent align



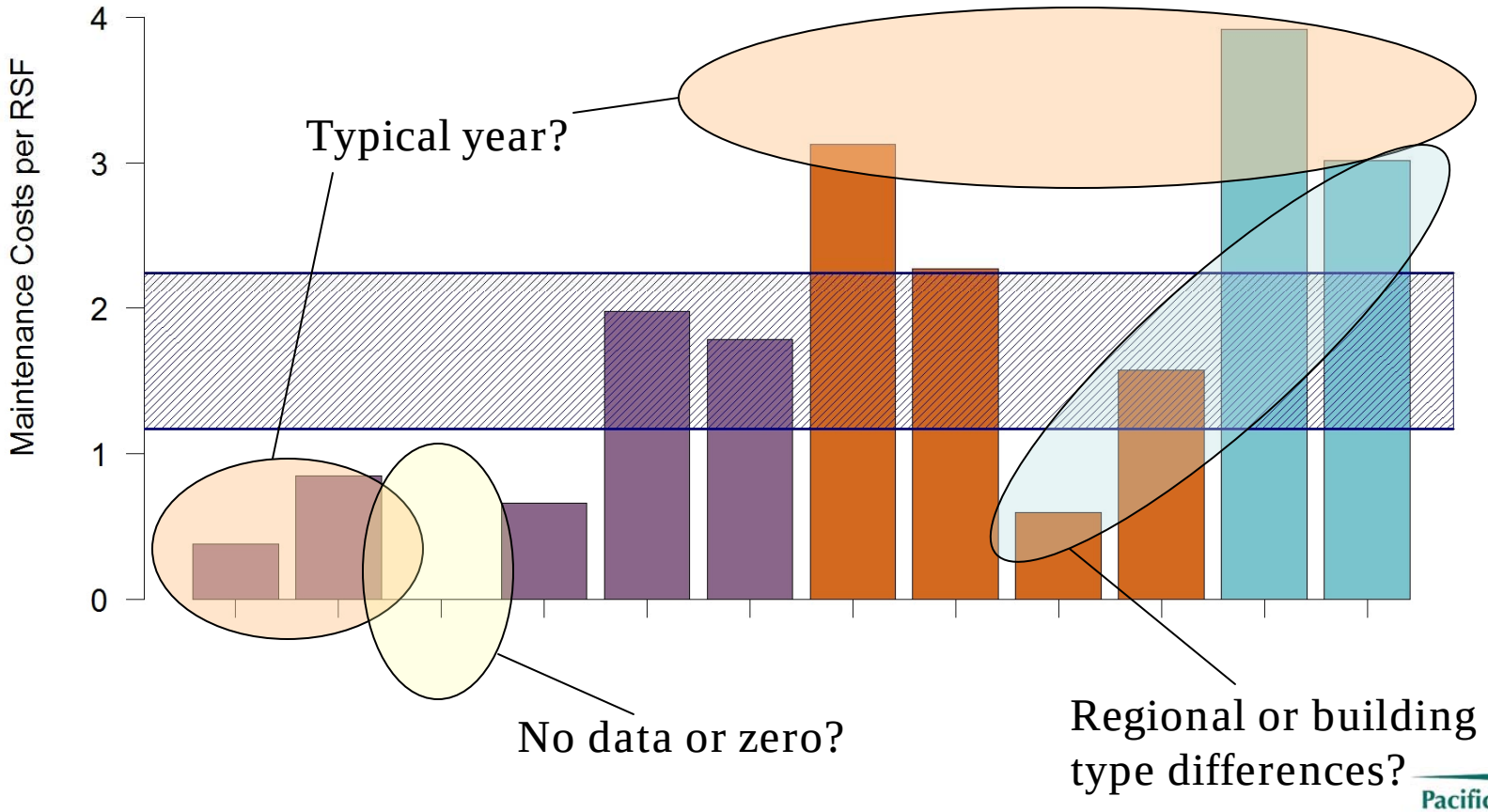
Lower domestic water use with water design intent

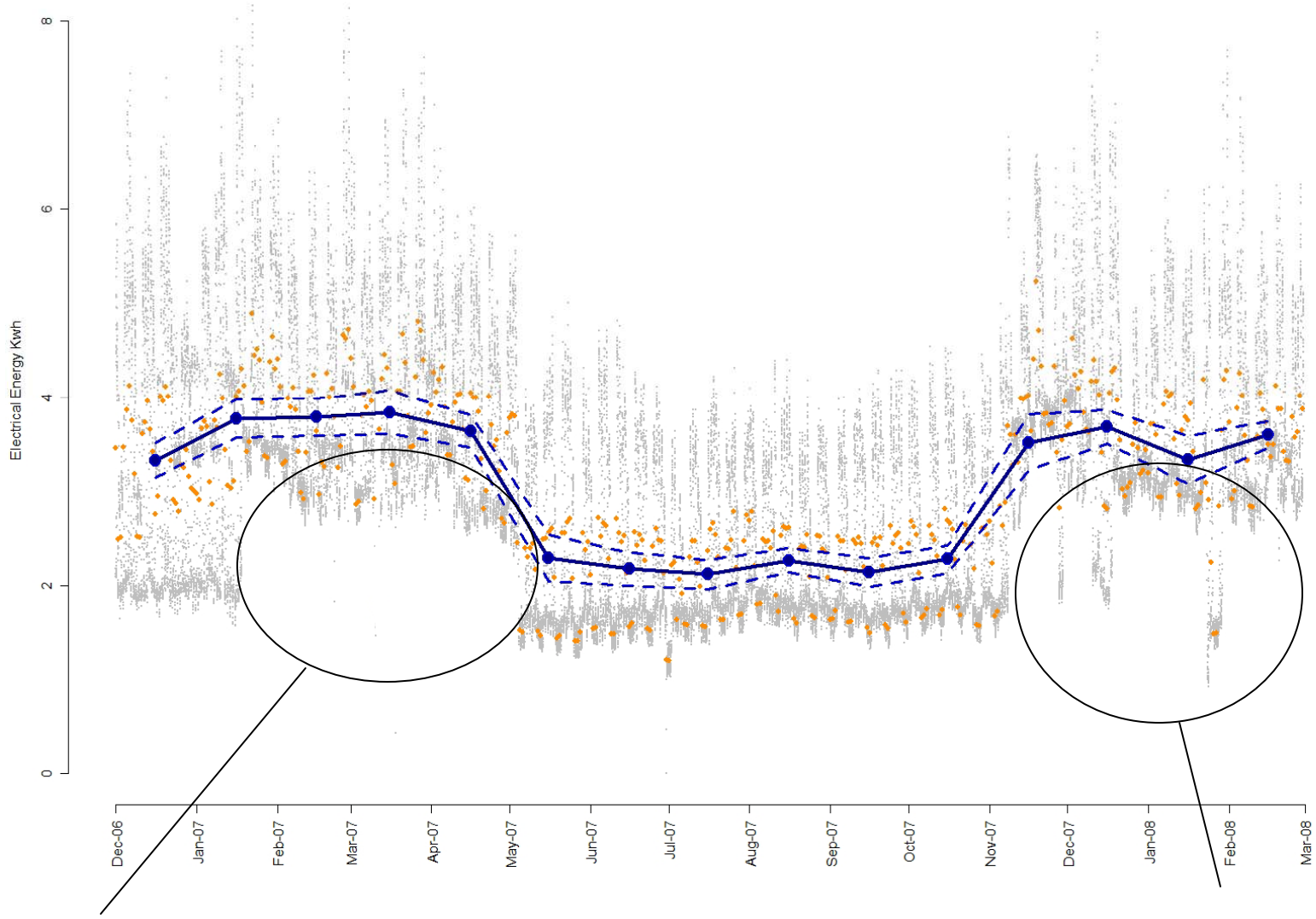


LEED Gold buildings performed better than baseline for all metrics



- Consistent, detailed data collection allows for more accurate performance measurement analysis





Equipment error or change in base load?

Is this a repeat in load changes?
Why does it drop off periodically?

One more…

- Site specific data can inform building managers on building's performance

Metrics	Annual Performance Measurements		Annual Reporting Metrics	
	Water Use (gal)	*800,414*	Gallons per occupant	*1,230*
	Process Water Use (gal)	*216,112*	Water Cost per occupant	*$29.09*
	Outdoor Water Use (gal)	*160,083*	Gallons per GSF	*1.44*
	Water Cost	*$5,468*	Water Cost per GSF	*$0.04*
	EnergyStar Score	*87*	Energy Use (kBTU) per GSF	*49*
	Energy Cost	*$5,958*	Energy Cost per GSF	*$0.94*
			Energy Emissions per building (metric tons CO_2 equiv)	*1,397*
	General Maintenance Cost	*$214,100*	General Maint Cost per RSF	*$1.57*
	Janitorial Services Cost	*$227,620*	Janitorial Services Cost per RSF	*$1.67*
	Grounds Maintenance Cost	*$4,000*	Grounds Maint Cost per RSF	*$0.03*
	Quantity of Maint Requests	*180*	Ratio of Maint Requests to Total Maintenance Jobs	*0.14*
	Quantity of Prev Maint Jobs	*1,078*		
	Solid Waste Generated (tons)	*39*	Solid Waste (lb) per occupant	*3.67*
	Solid Waste Cost	*$900*	Solid Waste Cost per RSF	*$0.01*
	Quantity Recycled (tons)	*2*	Solid Waste Cost per occupant	*$8.74*
	Recycling Cost	*-$71*	Ratio of Recycled to Solid Waste	*0.06*
	Survey # of Invitees	*100*		
	Survey # of Respondents (n)	*54*	Survey Return Rate	*54%*
	Commute Miles per occ (avg)	*22*	Commute Emissions per occ (metric tons CO_2 equiv)	*2.56*
	Commute fuel per occ (avg gal)	*276*		

Who Cares?

- Owners of building portfolios
- Building managers and operators
- Building designers
- Researchers
- Financial Investors

Different parties ask different questions.

The How, What and Why of WBPM

- How do sustainably designed buildings perform?
  - High level question, allows for summary data collection
- What design features offered significant performance impact?
  - Need more detailed data and ability to tie to design
- Why did the building perform the way it did?
  - Even more detailed data, analysis and interaction with building operators and occupants

So, now you want to do WBPM…

- Planning your study
  - What question(s) do you want answered?
  - What buildings will you include in your study?
    - Magnitude
    - Diversity
    - Baselines
    - Data availability

  - How will you manage the study?
  - Who will you share the results with?

Developing a WBPM Project

Project Initiation

Identify Buildings and Baseline

Select Performance Measurement Metrics

IFMA International Facility Management Association

BOMA International

CBE CENTER FOR THE BUILT ENVIRONMENT

ENERGY STAR

Building Characteristics
Water
Energy
Maintenance & Operations
Purchasing
Health & Productivity
Transportation

NAVFAC Naval Facilities Engineering Command

GSA

U.S.ARMY

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Developing a WBPM Project

Project Initiation

Identify Buildings and Baseline

Select Performance Measurement Metrics

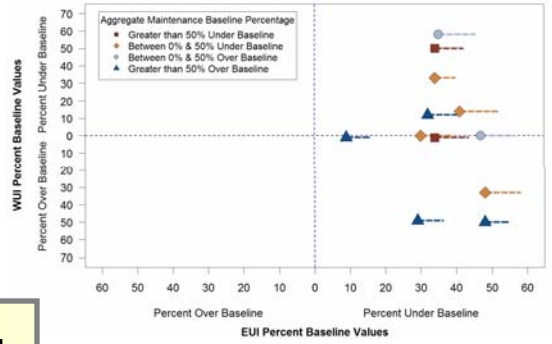
Project Execution

Identify possible metering needs

Gather site characteristics data & establish collection system for metered and non-metered data

Measure building performance for minimum of 12 months

Clarify data anomalies



Project Analysis

Compare Building Performance Data

Report Cost & Benefit Differences

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Lessons Learned

- Data Challenges
  - Not all data equally available
  - Difficult to collect consistent data from different buildings
  - Data normalization needed for comparability
  - More buildings' data needed for statistically significant findings
- Coordination
  - Multiple contacts are needed to collect information for the different metrics
  - Building managers and agency specialists are busy and have other priorities
- Starting with the "whole picture" can be overwhelming
  - Tailor the questions to the person being interviewed
- A reliable data collection system is a must
- Good analysis takes time!

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WBPM Protocol:
http://www1.eere.energy.gov/femp/pdfs/pnnl15217.pdf